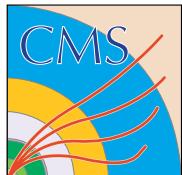


CMS HCAL TB2004

Shuichi Kunori

30-June-2004

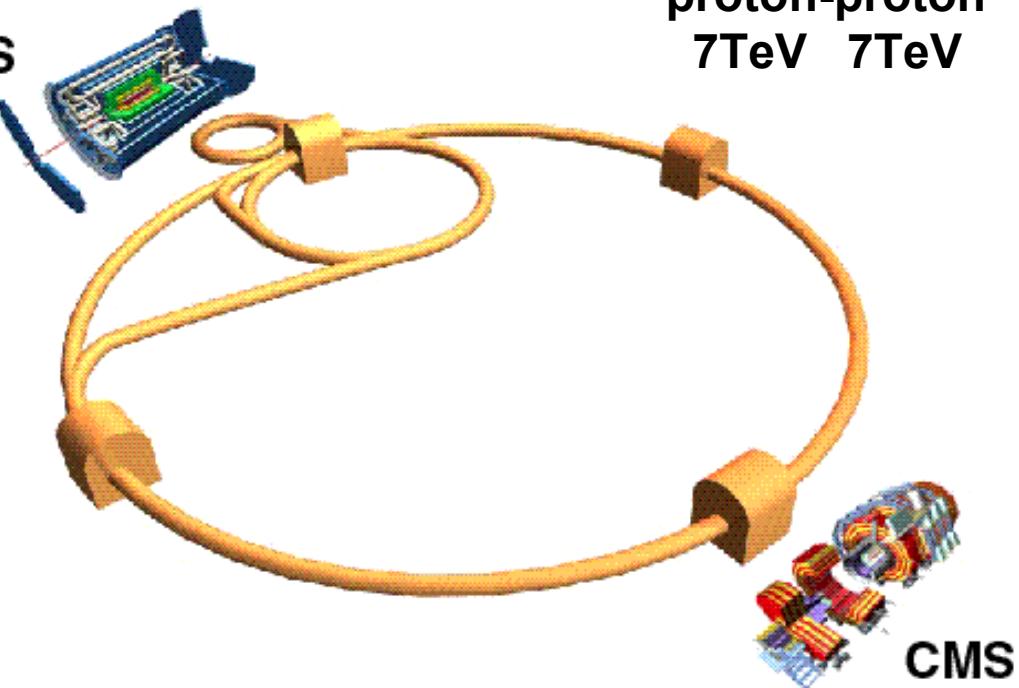


LHC



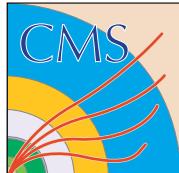
ATLAS

proton-proton
7TeV 7TeV

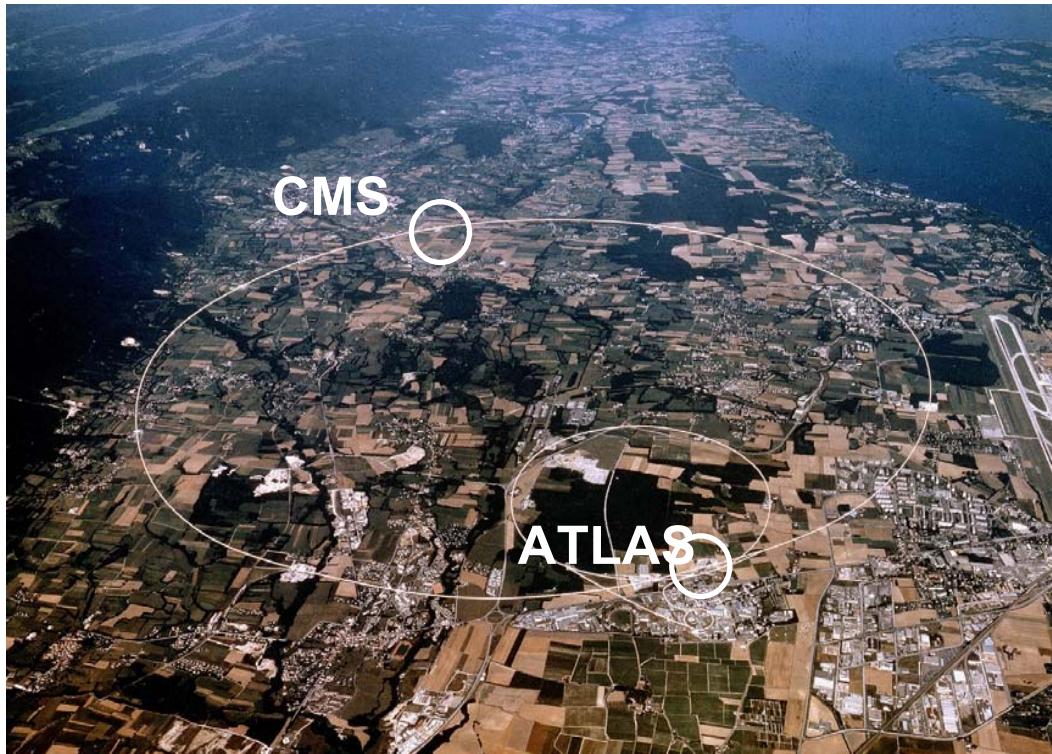


**European Center
for Nuclear Research (CERN)**

Main physics goal:
Higgs search
&
Physics beyond SM (SUSY)



The LHC



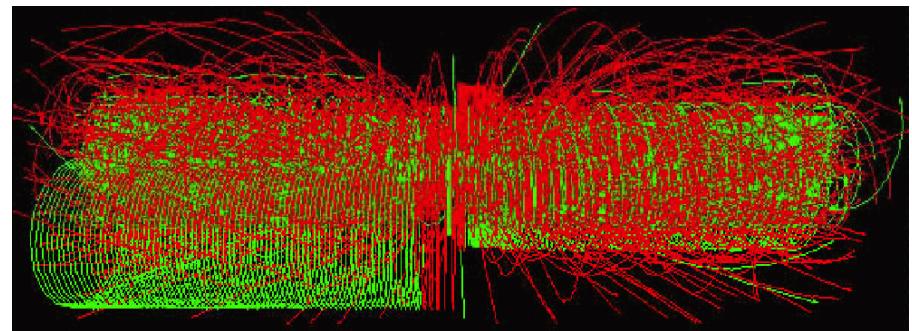
$R = 4.5 \text{ Km}$
 $E = 7+7 \text{ TeV (pp)}$

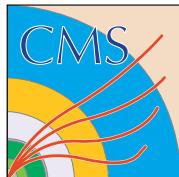
crossing rate
 $= 40 \text{ MHz}$
 (25 nsec)

design luminosity
 $= 10^{34} \text{ cm}^{-2} \text{s}^{-1}$

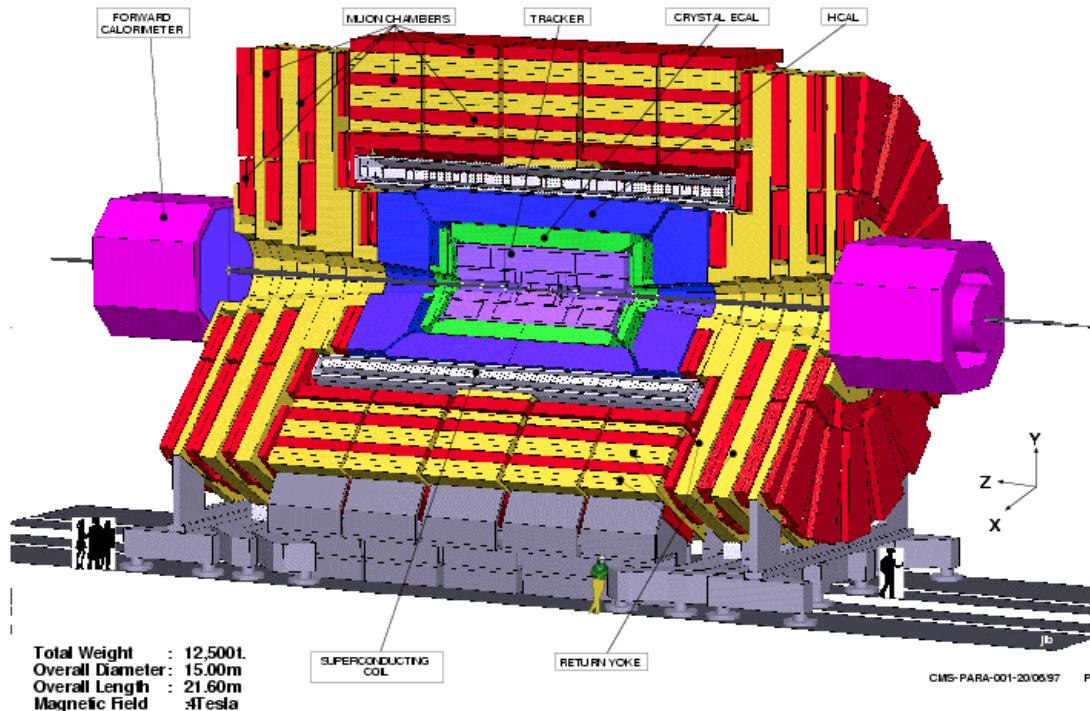
$\sim 20 \text{ pp interactions}$
 per crossing
 $\text{at design luminosity}$

$h \rightarrow 4\mu$ with 20 min. bias evt.





The CMS detector



Total weight	12500 t
Overall diameter	15 m
Overall length	21.6 m

All silicon tracker
micro strips (10M ch)
pixel (40M ch)
(5.4m long, 2.4m Φ : $|\eta| < 2.4$)

Hermetic calorimeter
ECAL: PbWO₄ crystal
HCAL: brass+scint.
($|\eta| < 3.0$)

in 4 Tesla solenoid
(12.5m long, 6m Φ in)

Robust muon system
DT+RPC (barrel)
CSC+RPC (endcap)
(in iron yoke: $|\eta| < 2.4$)

Fast cerenkov calor.
quartz fibber
($3 < |\eta| < 5$)



Surface buildings and main shaft



HCAL barrel



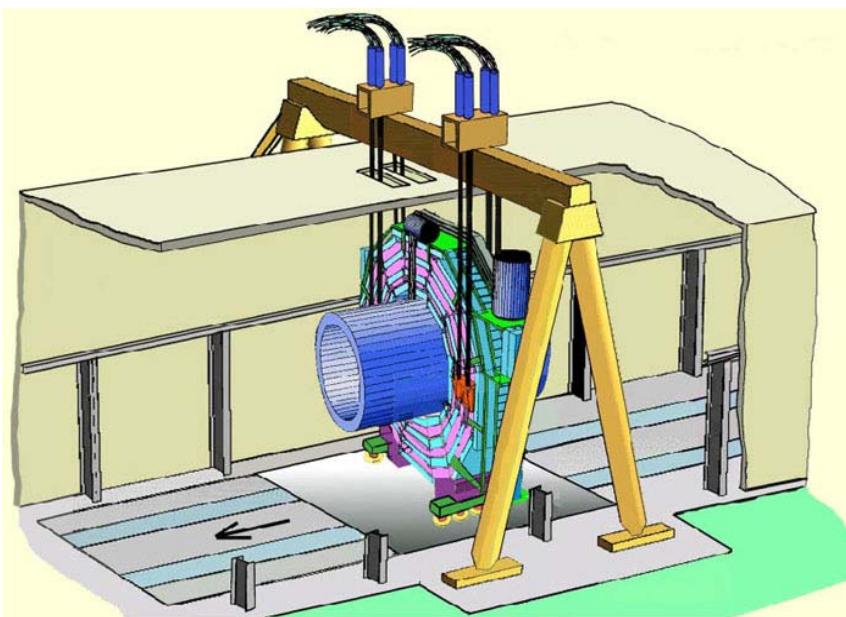
Muon barrel yoke



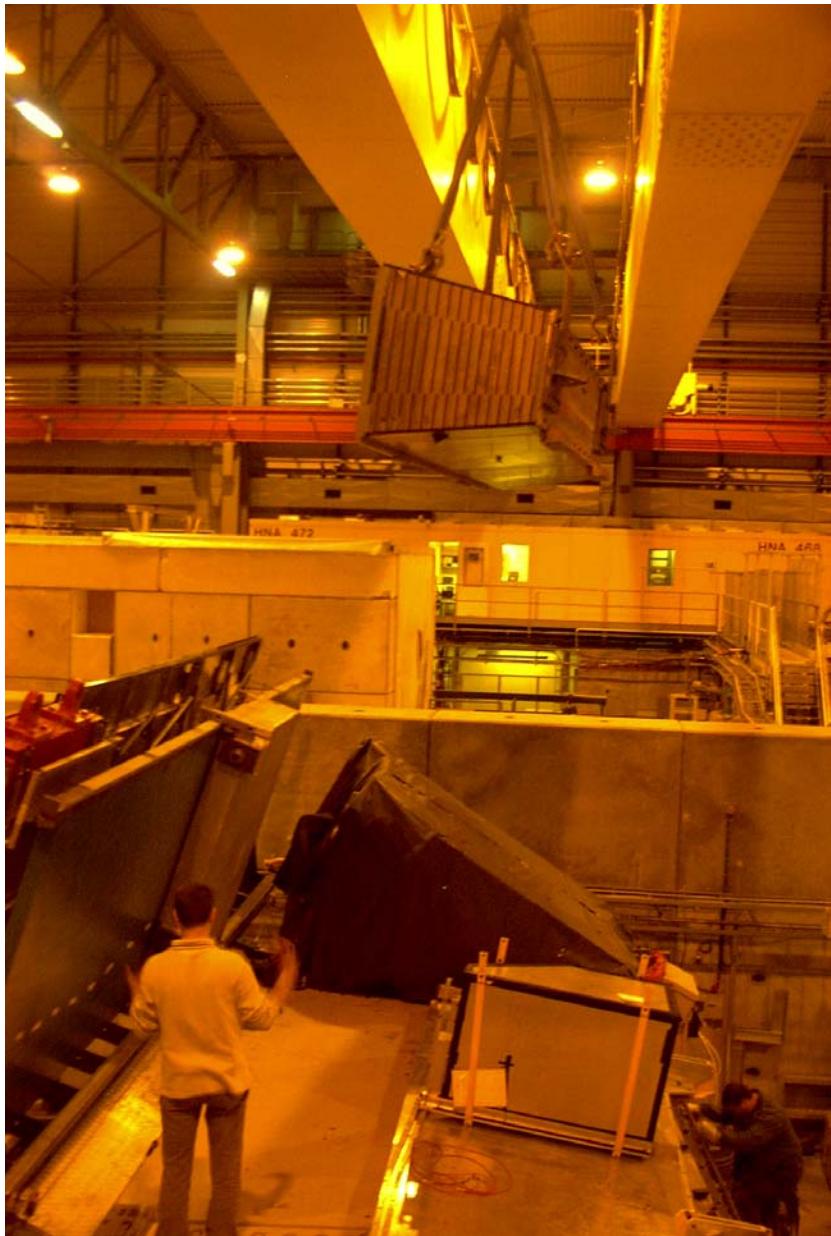
Installation of the first muon chamber

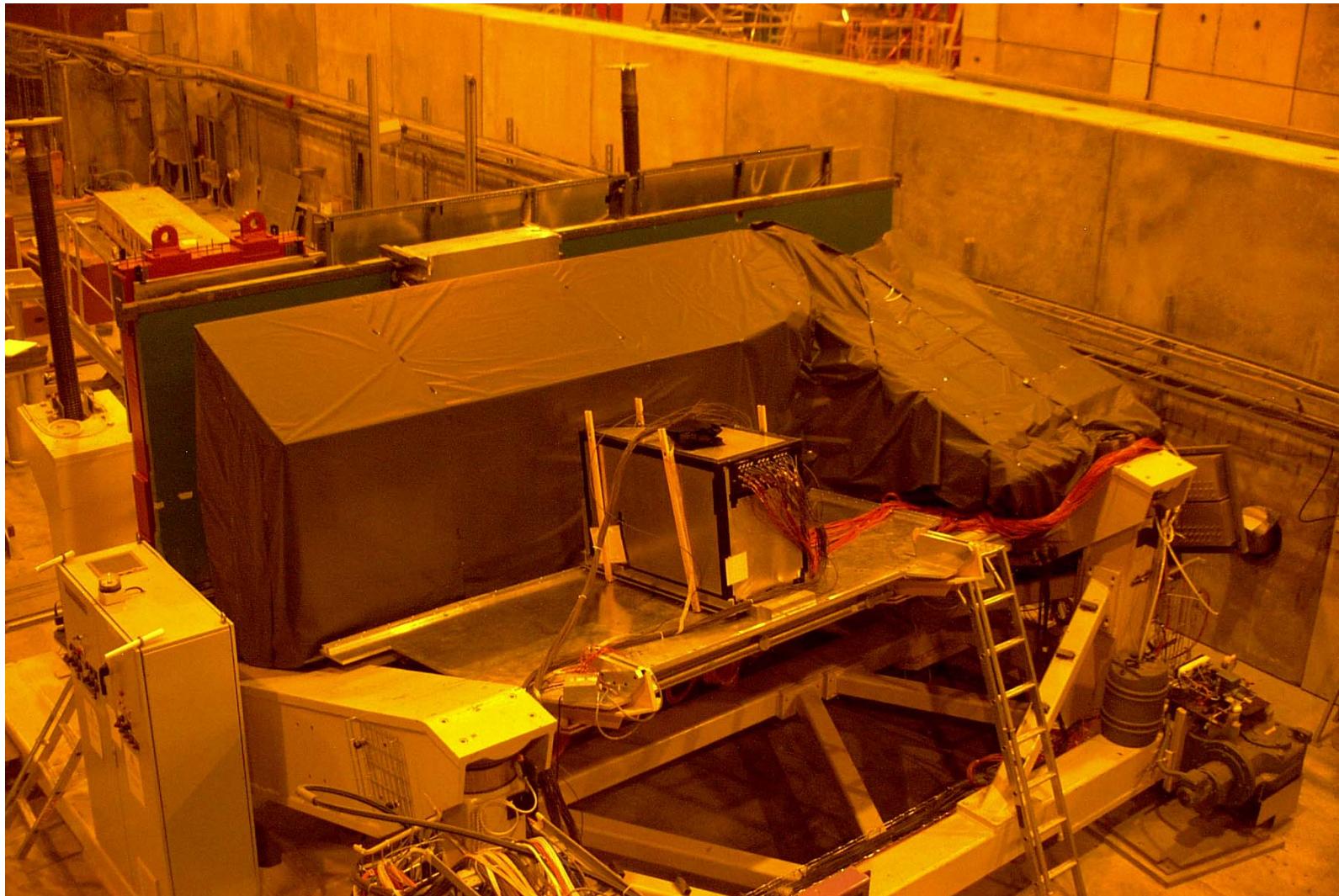


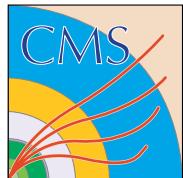
HCAL/Muon endcap



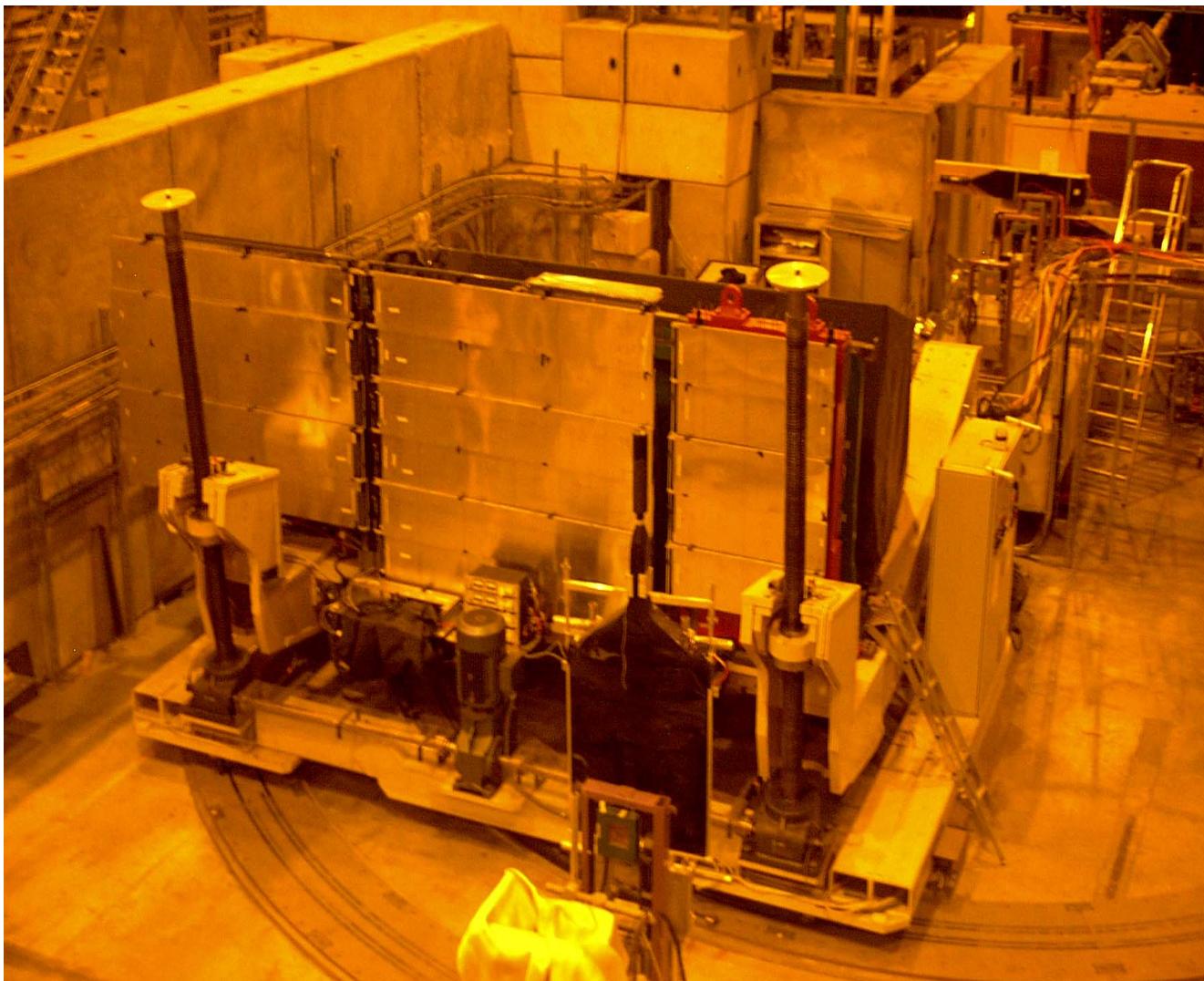


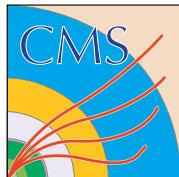




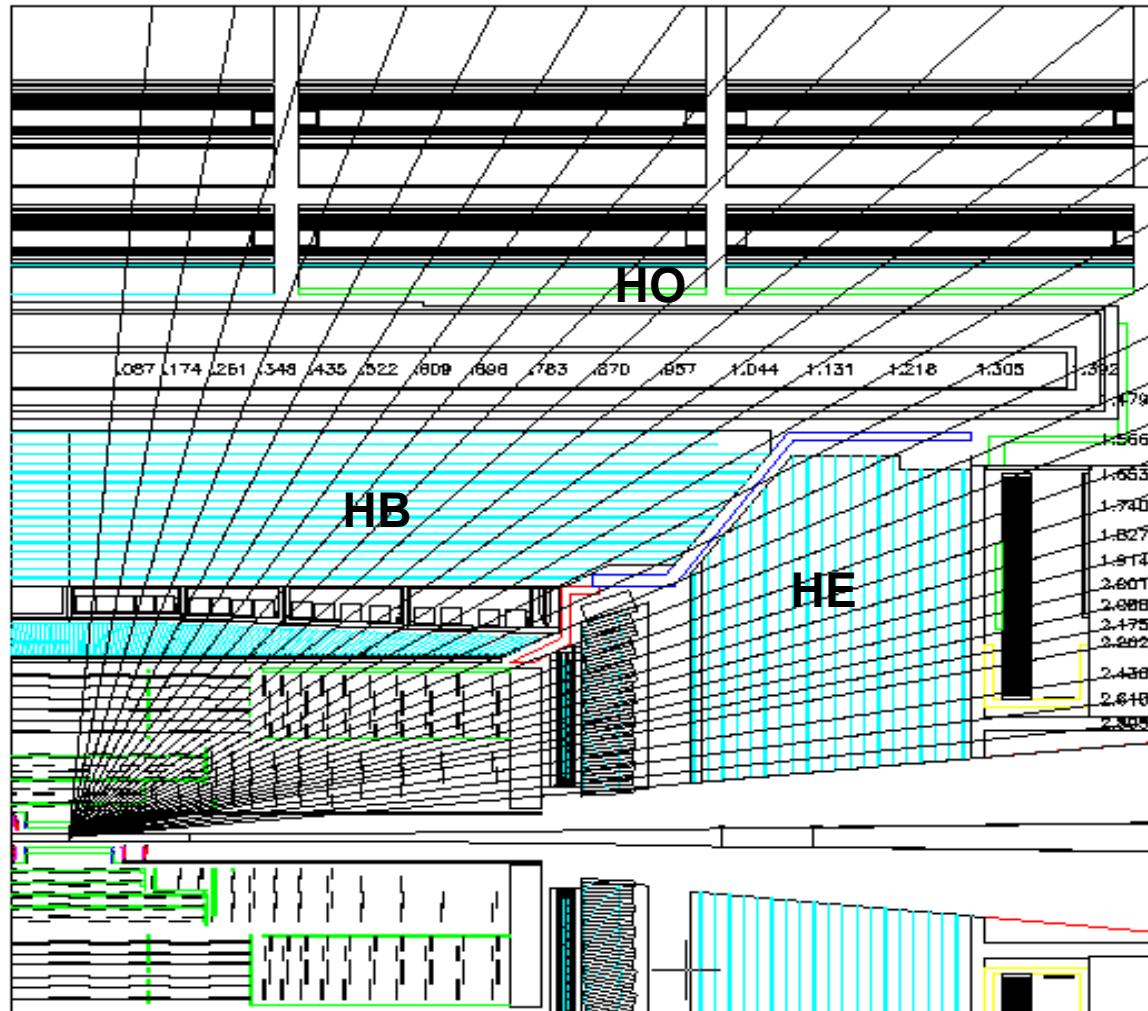


TB 2004: HO





Hadron Calorimeter

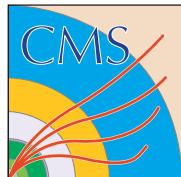


Sampling
Calorimeter

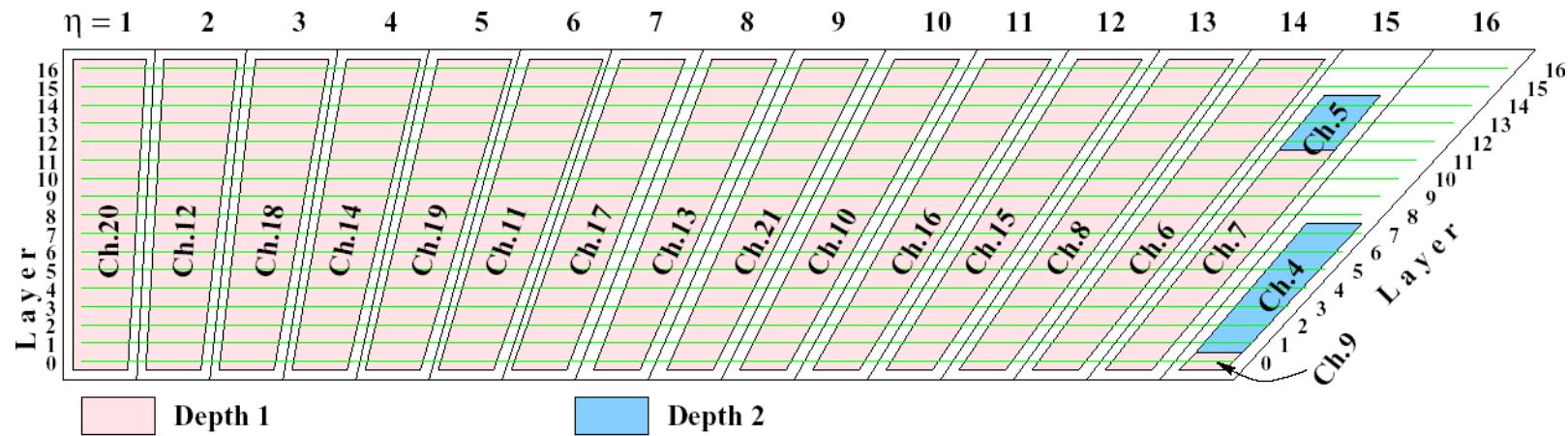
Brass+Scintillator

η - ϕ segmentation
 0.087×0.087

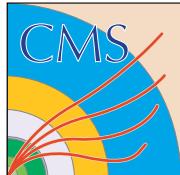
(coarser at $\eta > 2.0$)



HB1 Eta-depth segmentation



N.B. Layer counting starts from 0. 'SrcInd' variable, found in HTBDAQ_Data and representing tube number, starts from 1.



Data Sample

*** EC + HE: energy scan *** 2004-06-06

11491 e- 100GeV

11492 e- 100GeV

11493 e- 50GeV

11494 pi- 30GeV

11496 pi- 50GeV

11497 pi- 100GeV

11498 pi- 150GeV

11499 pi- 300GeV

11500 mu- 150GeV

*** EC + HB energy scan (no HO) *** 2004-06-06

--- eta=7, phi=3 Rundb (eta,phi)=(0.58,0.25) (10k/file) + 3 x30k events/file

pi- 150GeV (11509), 11511, 11512, 11513

pi- 300GeV (11514), 11515, 11516, 11517

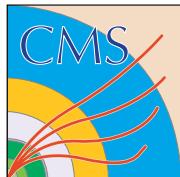
pi- 100GeV (11518), 11519, 11520, 11521

pi- 50GeV (11522), 11523, 11524, 11525

pi- 30GeV (11526), 11527, 11528, 11529

e- 50GeV (11530), 11531, 11532, 11533

e- 100GeV (11534), 11535, 11536, 11537

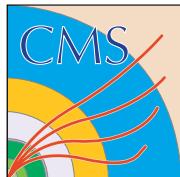


Detection of Fundamental Particles

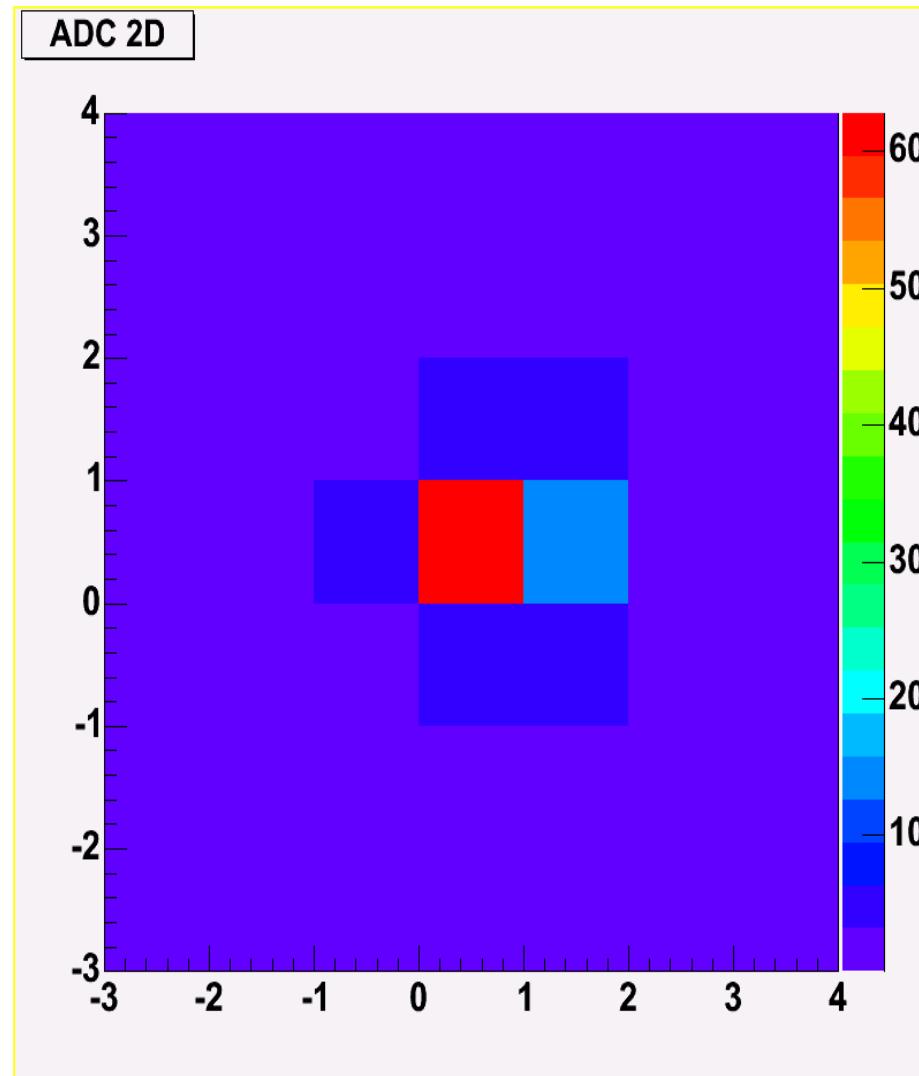
SM Fundamental Particle Appears As

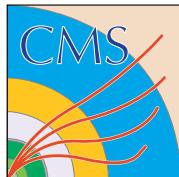
γ	γ (ECAL shower, no track)
e	e (ECAL shower, with track)
μ	μ (ionization only)
g	Jet in ECAL+ HCAL
$q = u, d, s$	Jet (narrow) in ECAL+HCAL
$q = c, b$	Jet (narrow) + Decay Vertex
$t \rightarrow W + b$	$W + b$
$\nu_e \nu_\mu \nu_\tau$	E_t missing in ECAL+HCAL
$\tau \rightarrow l + \nu_\tau + \nu_l$	E_t missing + charged lepton
$W \rightarrow l + \nu_l$	E_t missing + charged lepton, $E_t \sim M/2$
$Z \rightarrow l^+ + l^-$	charged lepton pair
$\rightarrow \nu_l + \nu_l$	E_t missing in ECAL+HCAL

type	tracking	ECAL	HCAL	MUON
γ				
e				
μ				
Jet				
E_t miss				

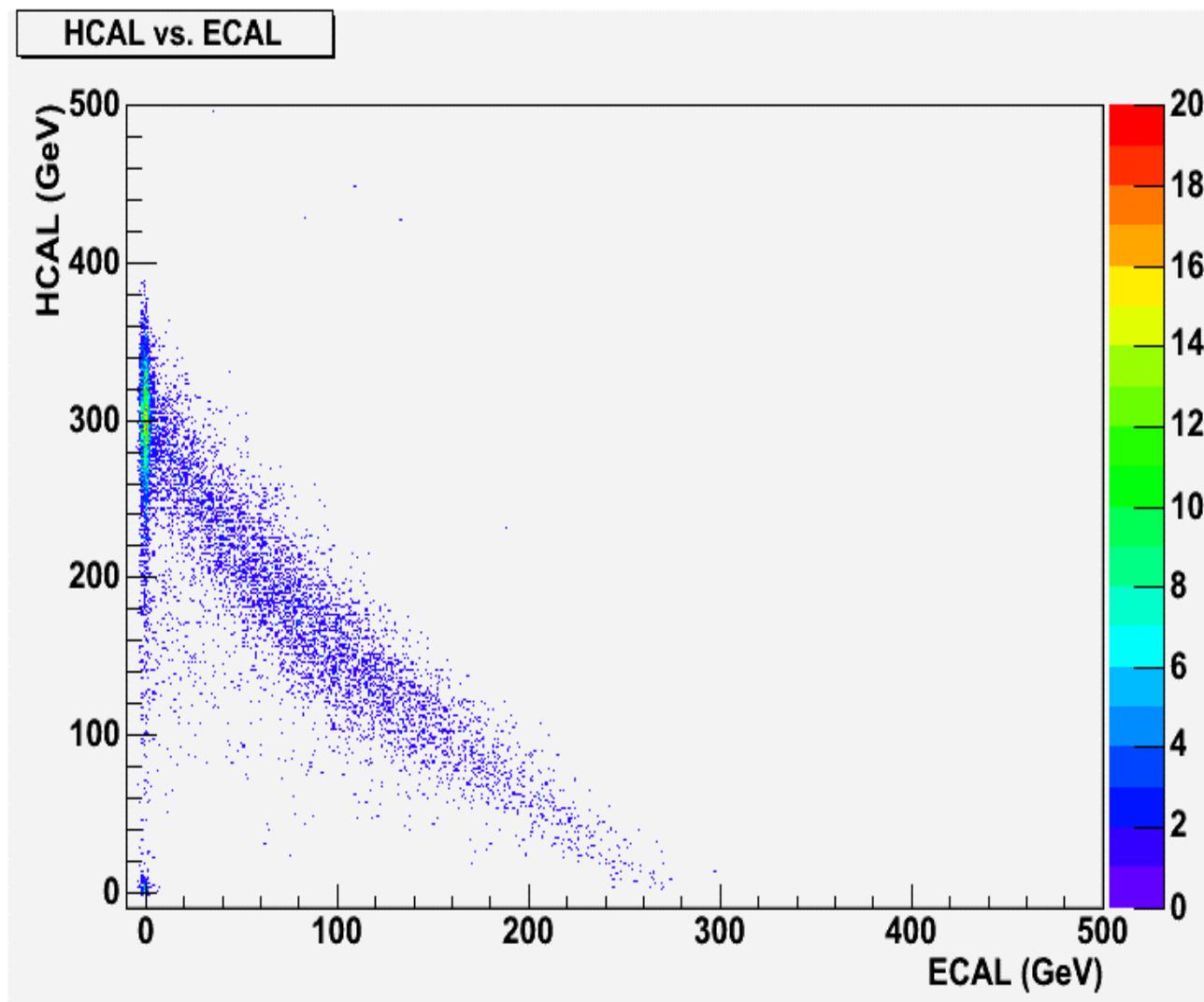


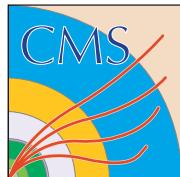
ECAL position adjusted: data with 2x2 trigger,



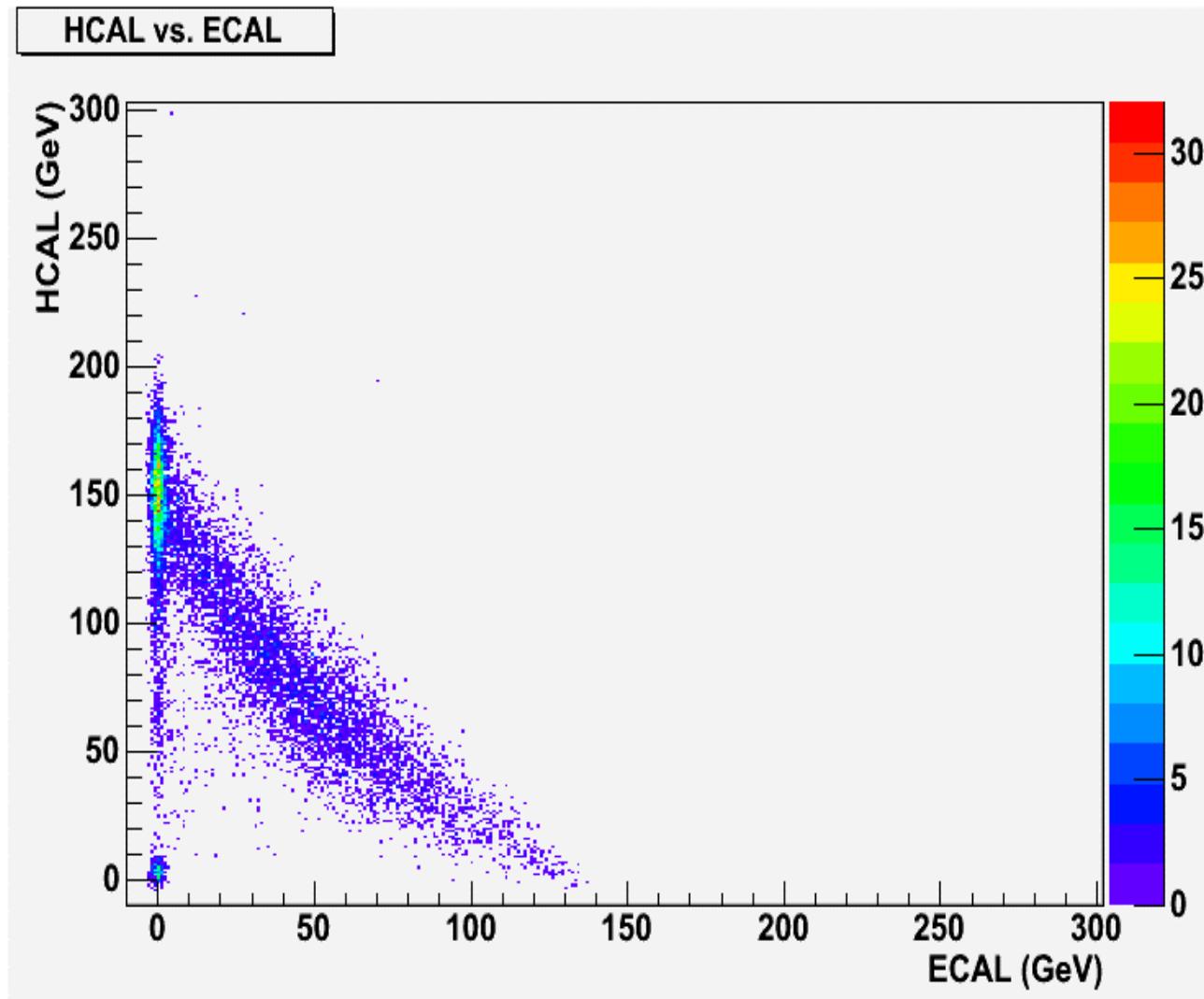


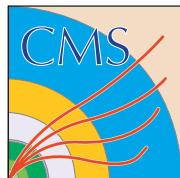
300 gev pion tune



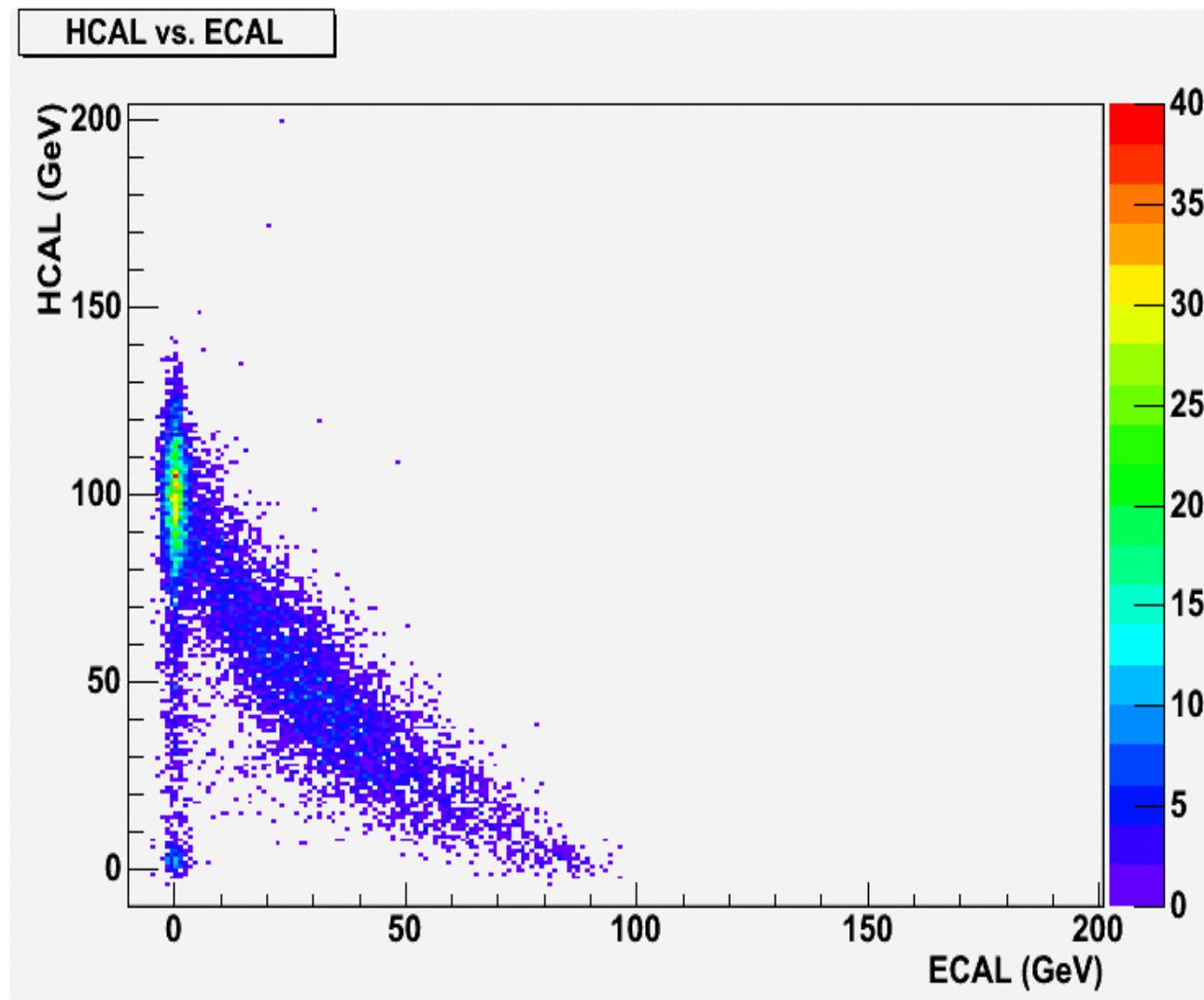


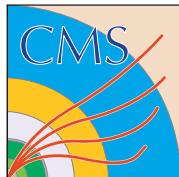
150 gev pion tune



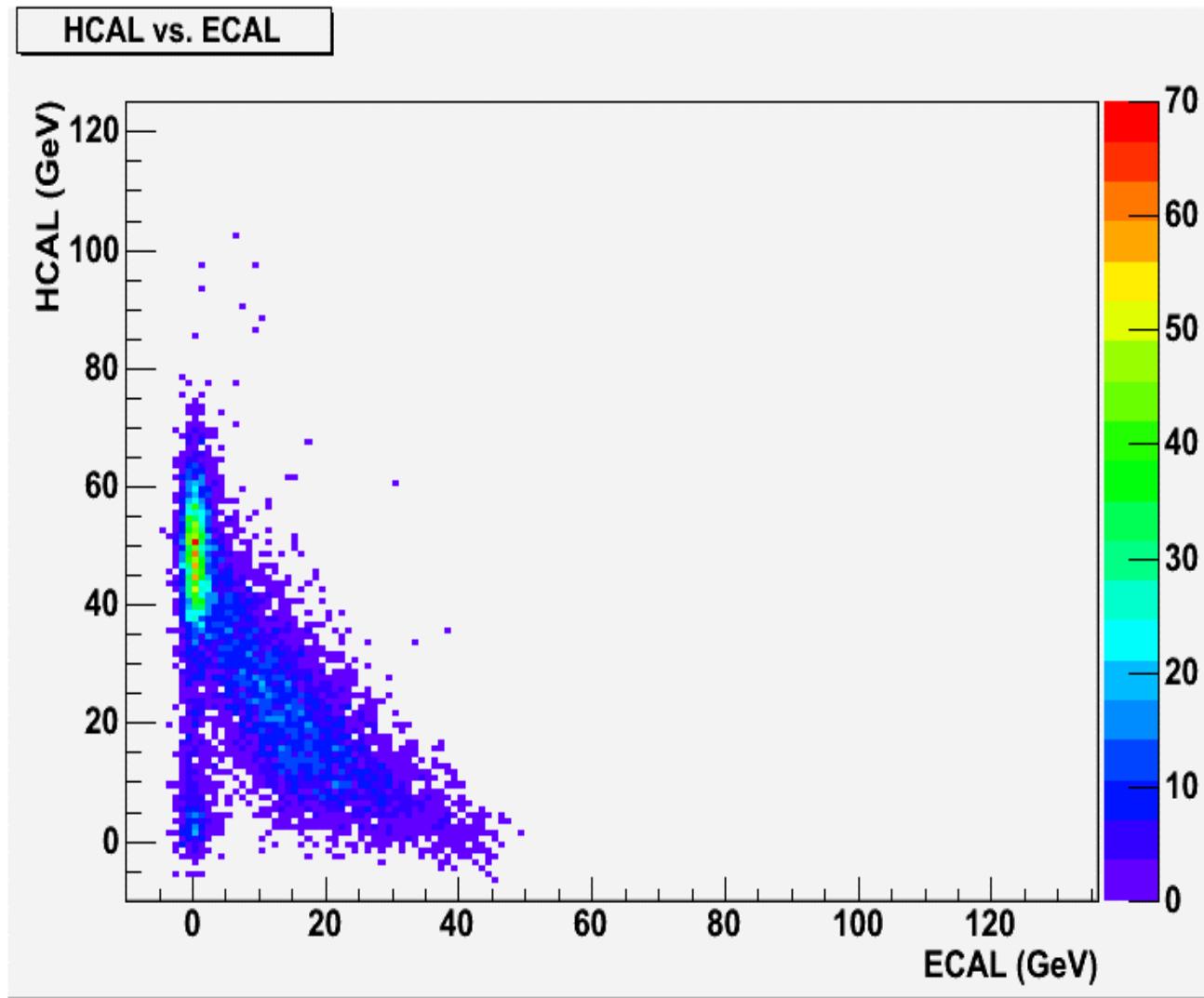


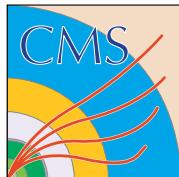
100 gev pion tune



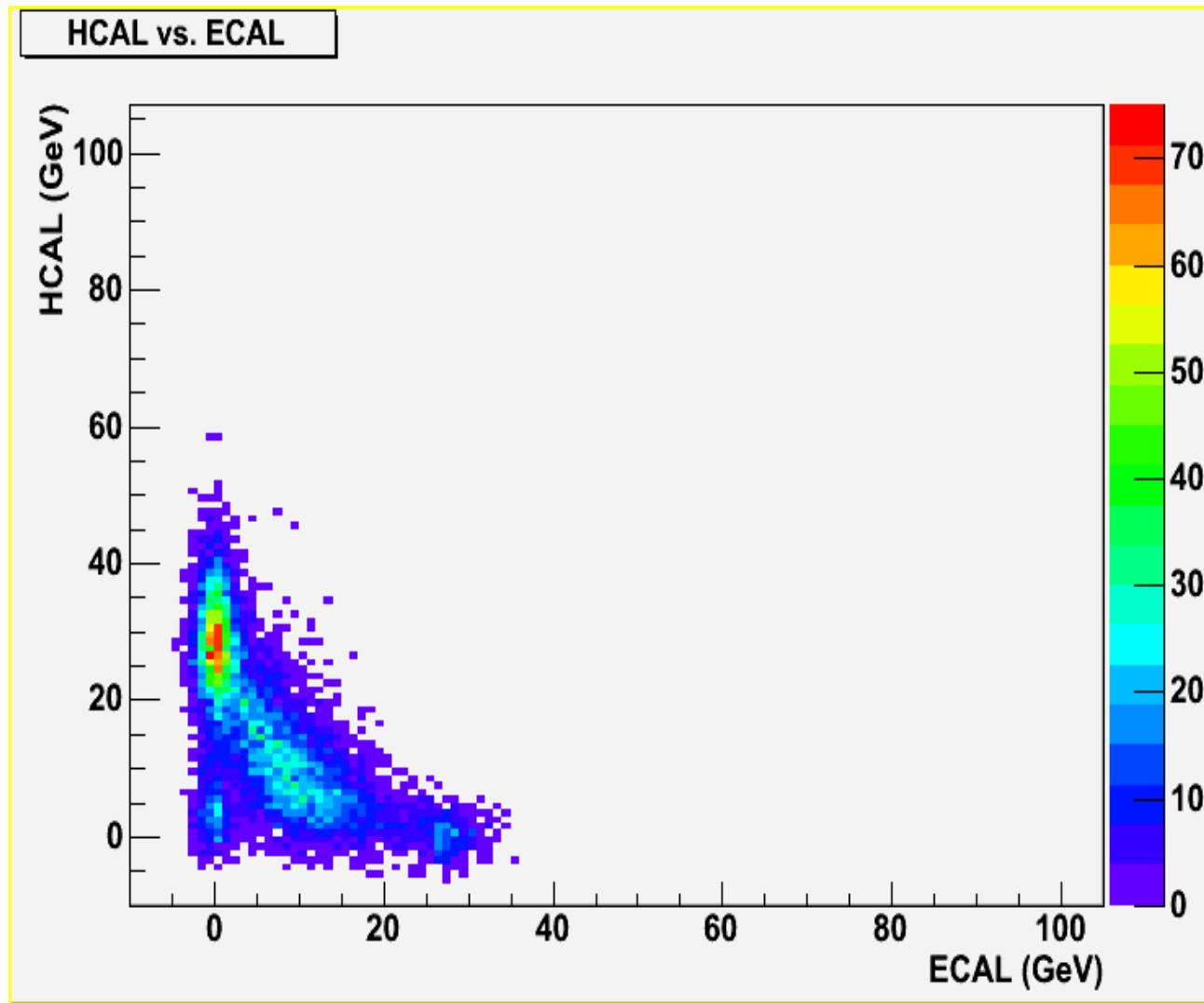


50 gev pion tune



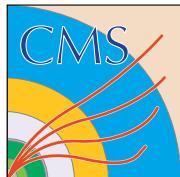


30 gev pion tune





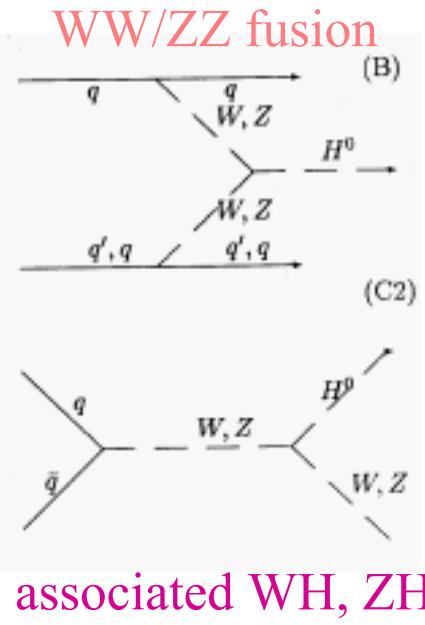
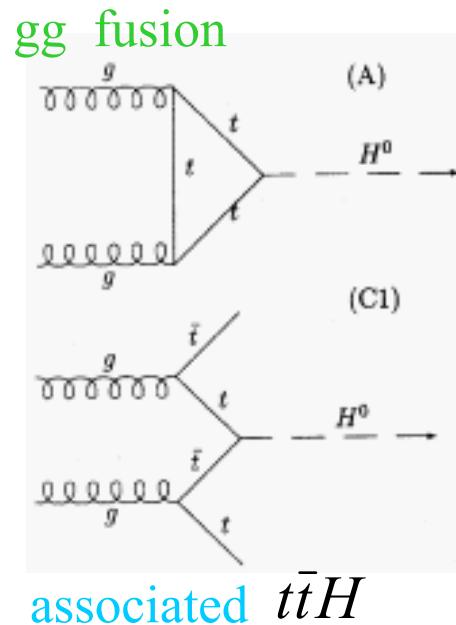
Additional Slides



The missing object- Higgs

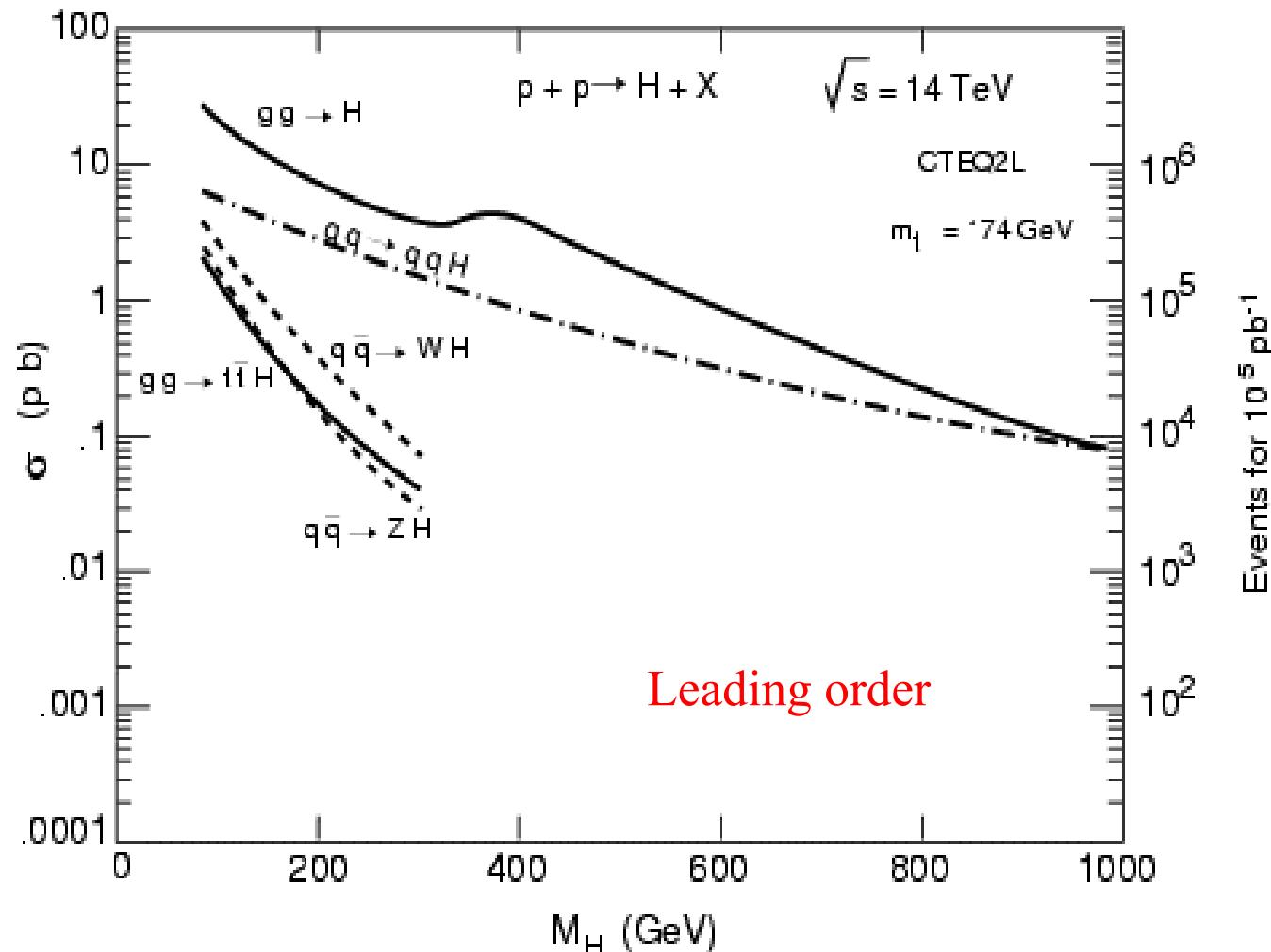
The Higgs boson is the missing object in the Standard Model, which provides a compact mechanism to generate all the masses in the Universe.

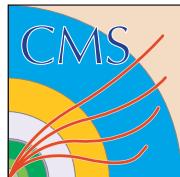
Higgs production at the LHC



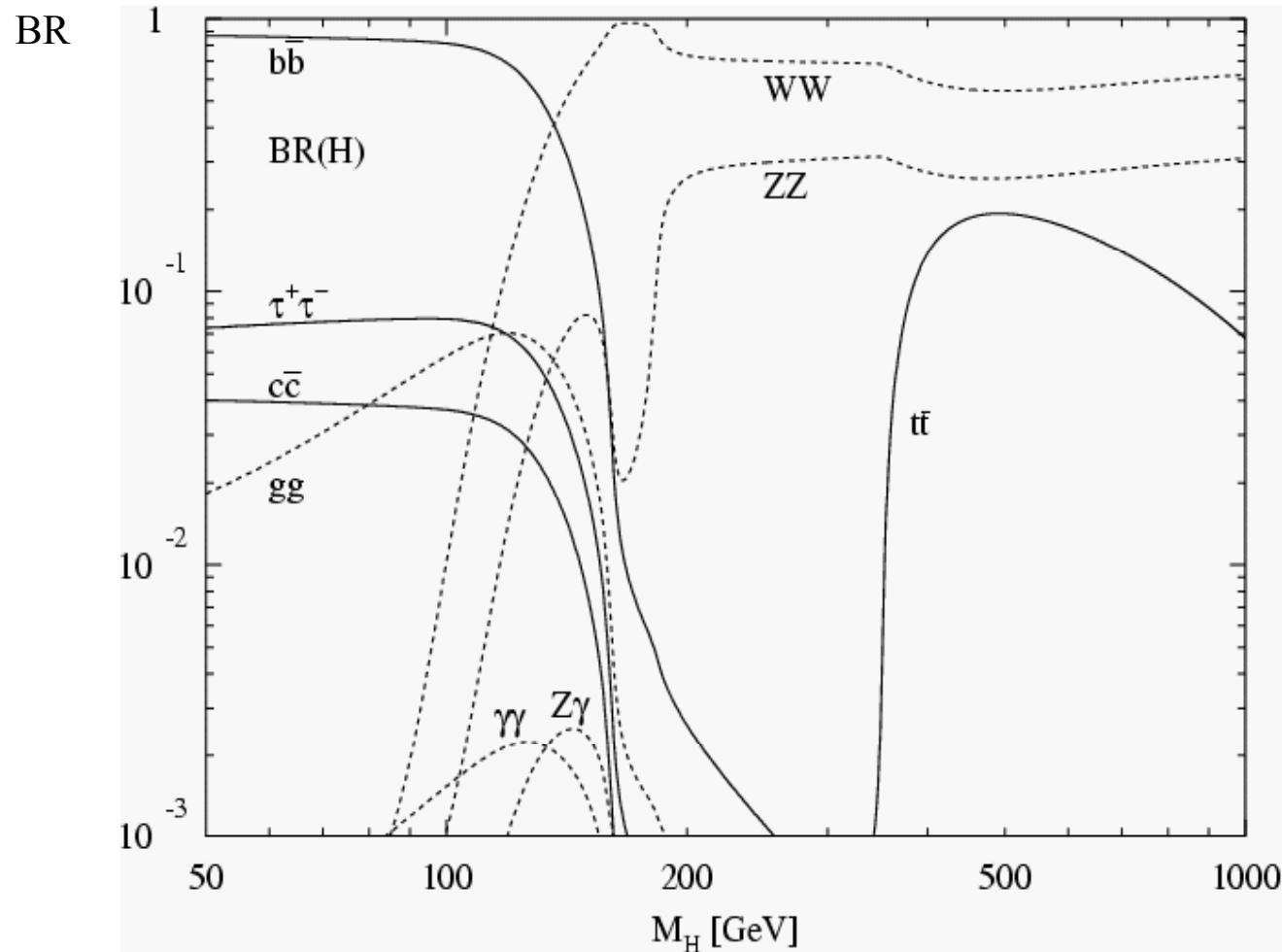


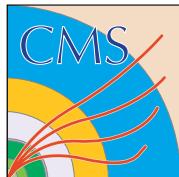
SM Higgs Production





SM Higgs decay





The Standard Model of Elementary Particle Physics

- Matter consists of half integral spin fermions. The strongly interacting fermions are called quarks. The fermions with electroweak interactions are called leptons. The uncharged leptons are called neutrinos.
- The forces are carried by integral spin bosons. The strong force is carried by 8 gluons (g), the electromagnetic force by the photon (γ), and the weak interaction by the W^+ Z^0 and W^- . The g and γ are massless, while the W and Z have $\sim 80, 91$ GeV mass.

